

Cases for Teaching Responsible Communication of Science

Monarchs in the corn: Role play version

Corn farmers have always faced pests that can damage their crop and undermine yields. One important pest is the corn borer, a worm that eats the root of the corn plant. Corn borers are especially damaging because they are difficult to reach, and difficult to kill.

The United States Environmental Protection Agency approved marketing and use of genetically engineered ‘Bt corn’ plants in 1995. ‘Bt’ stands for *Bacillus Thuringensis*, an organism that produces a toxin that is fatal to the corn borer. Bt corn has genes spliced into the corn genome, causing the plant to express this toxin in every cell.

Some people initially found it alarming that these plants produce their own pesticide. There was concern that what is toxic to pests might be toxic to people as well. But in the case of Bt toxin, this problem does not arise. Bt toxin responds to the gut chemistry of lepidopteran species like the corn-borer with fatal response. Because mammalian gut chemistry is different, the Bt toxin does not have the same effect on humans or other corn-eating mammals.

In 1999, John Losey, Linda Rayor, and Maureen Carter, entomologists at Cornell University in Ithaca New York, pursued research investigating the effects of Bt pollen on monarch butterfly larvae. They found evidence that pollen from Bt corn was potentially toxic to non-target species, including Monarch butterfly larvae.

Concerned about their findings, Losey, Rayor, and Carter submitted a brief paper in the prestigious journal *Nature*. Their paper reported the result of an experiment in which monarch butterfly larvae were fed milkweed leaves dusted with corn pollen. Larvae in the control group were given leaves dusted with pollen from an unidentified corn variety that had not been transgenically modified. Larvae in the experimental group were given leaves dusted with pollen from Bt corn. As they reported in the article, Losey and his colleagues found significantly increased mortality and health problems in larvae exposed to transgenic pollen.

The Cornell team passed their paper around to colleagues for comment and advice before submitting it for publication. The final version was carefully reviewed by scientists working in related fields. The published version appeared in *Nature* in May 1999 under the title “Transgenic Pollen Harms Monarch Larvae.” This paper, and the controversy surrounding its publication, is the focus of this case study.

Both before and after its publication, Losey’s paper has inspired vigorous debate. Some reviewers recommended that it should not be published, while others thought it urgent that it be published immediately. Some industry representatives, perceiving the study as a threat to the corn varieties sold by their companies, regarded the paper as a threat. Multiple different people report that there were attempts to bully the authors and the publishers not to publish it.

Even after the paper appeared in print, advocates and detractors lined up according to their interests in the case: Activist groups like Greenpeace immediately began urging that Bt corn and all other biotech crops should be banned, while industry advocates disparaged the paper and downplayed the risks. The paper did have the effect that it spurred a vigorous discussion, and a great deal of additional research on the environmental effects of transgenic crops.

This research did indicate that transgenic crops may have a significant influence on monarch populations. But more than a decade after the study was published, the hazard identified in it is not widely thought to be a significant risk: but subsequent studies are mixed, but many provided evidence that the in-field pollen risk to monarchs may be low. The more significant threat to comes with the advent of herbicide resistant crops: when farmers use more herbicide, there are fewer milkweed plants. Monarch larvae cannot survive without this “weed,” which is eradicated as a blight.

The controversy surrounding this paper is a classic and enduringly important case. More than a decade after publication of the paper that sparked this controversy, the issues involved in this case are still important and fresh.

Your task in this case study is to take a side on this controversial issue, considering yourself in the position of a reviewer assigned to evaluate this paper for publication in Nature. You will be assigned to one of four groups, each of which will provide the best available defense either for the view that (i) Losey’s (1999) paper should be published, or (ii) that Losey’s (1999) paper should not be published. You should provide the best defense you can for the position of the group to which you have been assigned. Include as many different arguments as you can, to make your defense persuasive to other participants. Readings associated with your group should be helpful to you as you formulate your argument, but you are in no way limited to the arguments included in these readings. Use your creativity to formulate arguments of your own, to project yourself into the perspective of those you have been assigned to represent, and to do some internet research on the issue to find material to use in defending your position.

A note about realism: This case is based on real events. The characters in the case, however, do not represent real individuals. Individuals involved in the publication and review process were interviewed, but their statements were recombined to produce four divergent positions. Your in-class debate is therefore likely to be more vigorous than the actual case.

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This case pack includes:

- Class Procedure: a detailed outline of each step of the exercise
- General Background Information on the case, for all groups
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Class Procedure: What to Expect

1. Set-up (~10-15 minutes, to be done in class). Your class will be divided into three groups. Each group will be assigned to represent one of the three character positions in the case. Make sure that you and your group members understand your task and your role.

2. Individual preparation (~60 minutes, to be done outside class as homework). You should read the brief two-page article "Transgenic Pollen Harms Monarch Larvae;" see the link in the General Background Information below. Think about the structure and methodology of the experiment described, and its significance.

Read the general background information explaining the context for the situation and the introduction to the three character positions. Read the specific background materials on the character position you represent to find three specific questions that should be explored in the class debate. You may want to read the specific background materials for the other character positions, too, to see what they are going to argue. You should also do some Internet research to build additional arguments not present in the case study itself. Your instructor may have assigned additional homework and readings.

Use all this information to prepare one to three arguments that support your position that can be used in your group debate. Arguments may be prepared in "bullet point" style, but should have enough detail that other group members can read and understand.

3. Group preparation (~10-15 minutes, to be done in class). Work with your group to synthesize the individual arguments each student created and discuss how they can work together to form a strong position relative to the three specific questions driving the debate. Create a 5-minute opening statement where your group will introduce its major arguments. During this planning process, you might decide who will speak in what order or which group member will present which arguments. Note that all group members should be actively involved in the group presentation, and every group member should present some part of the argument.

4. The drafting meeting (~40-60 minutes). Each group will be given 5 minutes for its opening statement followed by 5-10 minutes to respond to questions from the other groups. Groups will present in the order given below.

5. Debriefing (~15-20 minutes). At the end of the meeting you are divorced from your assigned role and the instructor will lead the group in a discussion of what you really think after the debate. Finally, the instructor will reveal the actual outcome of what really happened and you will be allowed to continue to reflect on your experience for a broader discussion of the issues.

General Background Information

For this activity, imagine it is 1999 and the authors have just submitted their monarch butterfly study for possible publication in Nature. You represent one of four groups that have access to the paper in advance of its publication, and have the opportunity to review it and to advise the journal editors about whether or not to publish the paper.

Since this case study asks that you focus on ethical issues in science communication, you should consider that the main issue under discussion is whether this paper should be published (communicated to both the scientific and the nonscientific the public) in its present state. Other background issues may be relevant to this question—in particular, it may be impossible to make the decision about publication without addressing disagreements about the scientific methodology involved in the study-- but please do not lose focus on the communication issue.

Likewise, particular, while the issue of safety is relevant for determining whether the paper should be published, the argument should not devolve into a general discussion of the safety of GM crops. However, the claim that Bt corn was introduced to the market before adequate tests of its environmental safety had been completed, for instance, is clearly relevant to the decision to publish this study. Make sure that other issues are raised in a way that contributes to the decision whether to publish, and the judgment whether the material in the paper has been framed in a way that avoids unnecessary misinterpretation.

Different interest groups represented below have different perspectives on this question. While readings associated with your interest group include arguments you may find useful in defending your group's position, you may find that these readings were written with other purposes in mind. Use the readings as a resource for arguments, not as a direct representation of the view you will defend. During the group presentation to the class, you should not read from sources provided: use your own words.

As you read these and develop your own arguments, consider the responsibility of reviewers in the publication process: What ethical guidelines apply to reviewers as they write reports on articles that have been submitted for publication? Does the representative from your group follow the appropriate guidelines?

You will want to take a close look at the original paper:

Losey, et al. 1999. "Transgenic Pollen Harms Monarch Larvae." Nature. Vol 399. 20 May 1999. p. 214, available at

<http://www.nature.com/nature/journal/v399/n6733/pdf/399214a0.pdf>

As you read this article, you should take notes to prepare yourself to make a presentation (with your group) that will refer to the main elements. As you read, consider the following questions:

1) Note that this paper was published as "Scientific Correspondence." Is this significant? Is this a more appropriate venue for results that are tentative, as compared with publication in the main body of the journal?

2) The cover of this issue showed an image of a monarch caterpillar eating a milkweed leaf covered in corn pollen. Was the decision to highlight this paper in this way, as a feature publication, a questionable decision?

3) Consider the title of the paper: Is the title accurate? Does the experimental work provide adequate support to show that “Transgenic pollen harms monarch larvae?” Is this title likely to incite an inappropriate public response? Are there other titles that would be more appropriate?

4) When this paper was published, agricultural biotechnology was quite a new thing. Many people had concerns and fears about this technology, but the public was not very informed about its safety. Would it be appropriate for the journal or the authors to take these considerations into account when deciding whether to publish, or when deciding how to describe the work undertaken in the study? For example, should the paper be framed to avoid inciting or increasing the level of public fear about biotechnology? Should it be framed to increase people’s reservations about the environmental effects of biotechnology?

Further Reading (optional): For additional information on the case and surrounding events, see: Shelton, A.M. and Sears M.K., 2001. “The Monarch Butterfly Controversy: Scientific Interpretations of a Phenomenon.” *The Plant Journal* 27(6):483-488.

Note: As you consider this source, ask yourself which of the interest groups, if any, the authors would be classified.

Introduction to the Character Positions

GROUP 1: Skeptical scientists: Reviewers assigned to evaluate Losey (1999) for publication. Members of this group are scientists who are skeptical of the value of the research in Losey's paper. Members of this group have an interest in maintaining the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, they are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally, but this does not mean that they support the publication of any and all research results. As a member of this group, you should explain the strongest reasons against the decision to publish the article under consideration.

GROUP 2: Supportive scientists: Reviewers assigned to evaluate Losey (1999) for publication. Members of this group are scientists who support the value of the research in Losey's paper. Members of this group have an interest in maintaining the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, they are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally. As a member of this group, you should explain the strongest reasons in favor of the decision to publish the article under consideration.

GROUP 3: Biotech researchers concerned that this publication might needlessly undermine a valuable technology. Members of this group are optimistic about agricultural biotechnology, and have a professional interest to insure that the results of their scientific work will not be dismissed for inappropriate reasons. They are interested to defend Bt corn against what they may regard as an attack by Losey and his team, since their ability to develop and market new agricultural biotechnology products may depend in part on the success of this product. Members of this faction believe that agricultural biotechnology is valuable, safe, and environmentally appropriate. They are interested to support this technology, and to respond to arguments that would indicate otherwise.

GROUP 4: John Losey's research team, Cornell University. Members of this team are scientists responsible for the research in Losey (1999), and are eager to promote the publication of their work. As a member of the research team responsible for this paper, you have many of the same interests as members of the groups above: like them, you have a general interest to maintain the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, you are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally. You have the additional motive of self-interest: members of this team have a personal as well as an impartial interest in the publication of this paper, since it is their own work. As a member of this group, you should be prepared to respond to the arguments of skeptical reviewers, and to defend the integrity and value of the research reported in the paper.

Specific Background Materials for Group 1

GROUP 1: Skeptical Reviewers assigned to evaluate Losey (1999) for publication. Members of this group are scientists who are skeptical of the value of the research in Losey's paper. Members of this group have an interest in maintaining the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, they are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally, but this does not mean that they support the publication of any and all research results. As a member of this group, you should explain the strongest reasons against the decision to publish the article under consideration.

Reasons Against Publication: You should argue that various features of the study make it inappropriate to publish the results at this time. Consider developing some of the arguments below:

- (1) Lack of proper control: an unidentified corn variety was source for pollen in control group.
- (2) The study lacks precise information on what dose of pollen was used in the study, and does not investigate the response of larvae at varying doses.
- (3) Lack of choice: researchers did not discover whether monarch larvae simply avoid leaves that are pollen-covered. The larvae in this study had no alternative.
- (4) This study identifies a hazard without analyzing the risk.

(Note: A 'hazard' is simply anything that can cause harm. A 'risk' involves quantifying the harm and multiplying it by the probability that the harm will be manifest. For example, riding a bike exposes you to the potential harm of a skinned knee. The correlate risk you undertake on a bike is the quantitative disvalue of a skinned knee (measured, perhaps, by the amount you would be willing to pay to avoid one) multiplied by the probability that you'll have an accident and skin your knee.)

- (5) There is a serious potential that these results will be misrepresented in the popular press, and misunderstood by the public. "Further study should be done before airing this issue."

Are there additional reasons you should include on this list?

Note: As you read the fictional reviewers' report on the next page, consider the arguments offered and their relevance to the decision whether or not this article is ready for publication. Note that, in this case, considerations about the experimental design are relevant to the publication decision: it is impossible to answer the question whether the paper is ready for publication without considering whether the experimental design was appropriate. You will need to argue for the position described in this report, but you should also think critically about the reasons offered. Be ready to respond to objections from members of other groups.

Reading for Group 1: Reviewer Report --"Transgenic Pollen Harms Monarch Larvae"

The paper under review reports the result of a preliminary study evaluating the toxicity of transgenic Bt pollen for monarch butterfly larvae. As one might expect, the results show that Bt pollen can be toxic to monarch larvae-hardly a surprising finding, since it is well known that Bt proteins are toxic to lepidopterans (the order of insect that contains monarch butterflies). Bt corn was developed expressly to target another lepidopteran, the corn borer, and one might expect that the same gut chemistry that makes Bt toxic to this target species would render it toxic to other

'leps' as well. The innovative feature of this study is that it identifies an exposure route for non-target leps that has not previously been considered: While monarch larvae don't normally eat corn plants, it's relevant to note that they may be exposed to corn pollen that falls on the leaves of milkweed plants.

Unfortunately, there are major problems with the experimental design employed in this study: First, the researchers provide no precise measure of the pollen density found to be toxic: they report only that the density was set to "visually match densities on milkweed leaves collected from corn fields." While this implies that the pollen density tested is similar to what one might find in the field, the authors provide no way to verify or test this. Because the pollen density was not more precisely reported (and may not even have been more precisely measured), the experiment is unrepeatable: researchers who might hope to attempt to reproduce the reported results are out of luck.

The main finding of the paper is that pollen from Bt corn is toxic, at some unspecified level of exposure, for monarch larvae. But for virtually any substance at all, there is some level of exposure that would be toxic: if you feed monarch larvae enough water, they will die. But this doesn't mean that water is dangerously toxic to monarch larvae.

There are valuable studies these researchers might have pursued: it would be valuable to know how toxic Bt pollen is at varying levels of exposure, but the study reported did not vary the vaguely-described exposure rate used. It would be important to know more about the likelihood of pollen ingestion under conditions that more closely resemble field conditions: monarch larvae are highly mobile-if they disprefer pollen-covered leaves, do they move to another plant, or another leaf on the plant? In the study under consideration, the larvae had no choice, since pollen-covered leaves were the only available food source.

The main problem with the paper is that it is fatally incomplete: it identifies a potential hazard to monarch larvae without providing enough data even to begin to evaluate the risk. To know the risk to monarch larvae, we would need to know the likelihood that they would encounter and consume a harmful dose of Bt pollen.

Because this study reports only the unsurprising finding that there is a dose level (an unspecified level) at which Bt pollen is a hazard to monarch larvae, it does not provide resources to evaluate the risk to monarch larvae or the impact on monarch populations. The fact that the study, as reported, is unrepeatable is a clincher: this paper should be rejected for publication.

Specific Background Materials for Group 2

Group 2: Supportive Reviewers assigned to evaluate Losey (1999) for publication. Members of this group are scientists who support the value of the research in Losey's paper. Members of this group have an interest in maintaining the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, they are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally. As a member of this group, you should explain the strongest reasons in favor of the decision to publish the article under consideration.

Consider whether there are other interests members of this group are likely to share.

Reasons for Publication: You should argue that various features of the study make appropriate, and perhaps even urgent to publish the results at this time. Consider developing some of the arguments below:

- (1) The topic is important and the results of this study are relevant for the evaluation of the environmental impact of Bt corn.
- (2) While the study is incomplete in many respects, all scientific studies are incomplete in one respect or another. Incompleteness can never be a reason not to publish significant findings.
- (3) The scientific work described in the study was responsibly done, and the results are not overstated.
- (4) This paper should prompt more research investigating the effects of Bt crops on non-target species, and more generally research on the environmental impact of new crops. Such research is needed.
- (5) This product (Bt corn) was introduced into the market with inadequate testing of implications for the environment and for non-target species. In this context, it is justifiable to publish research that will bring public notice to this problem.

Are there additional reasons you should add to this list?

Note: As you read the fictional reviewers' report on the next page, consider the arguments offered and their relevance to the decision whether or not this article is ready for publication. Note that, in this case, considerations about the experimental design are relevant to the publication decision: it is impossible to answer the question whether the paper is ready for publication without considering whether the experimental design was appropriate. You will need to argue for the position described in this report, but you should also think critically about the reasons offered. Be ready to respond to objections from members of other groups.

Reading for Group 2: Reviewer Report-- "Transgenic Pollen Harms Monarch Larvae"

This paper reports an experiment in which monarch butterfly larvae were fed milkweed coated with corn pollen. In the test group, the pollen was from a variety of corn modified to express proteins from *Bacillus thuringiensis* (Bt). In the control group, the pollen was from an unidentified but unmodified corn variety. As reported, larvae that consumed pollen from the transformed corn were significantly harmed.

The experiment described is limited in several important respects: The researchers did not precisely reproduce field conditions, and there is no way to check whether the pollen densities used in the lab are representative of pollen densities on milkweed plants outside the lab. In spite

of this limitation, the result is important and significant: It is important to know that there is a level of pollen density that does not cause monarch larvae to reject the leaves, but at which the Bt toxin is still harmful. The experimental design is appropriate, and does provide significant support for this important claim. As the authors themselves note, it will be necessary to pursue follow-up research to determine the likely exposure rates, to determine the toxicity of Bt pollen at different exposure rates, and to discover the number of larvae likely to be affected by Bt pollen.

In spite of these limitations, the results are significant and the experimental design is appropriate. The authors do not over state their case, noting that their result supports the need for future research. While the study leaves open many important questions about the risks posed to monarch larvae in actual field conditions, this incompleteness is not a fault: all studies are incomplete in one way or another. The results of this study do support the researchers' contention that further research should be conducted to evaluate the risk to monarch larvae and monarch populations in the field.

The results of this research are especially important because Bt corn is so widely in use, and because the possible environmental effects may therefore be similarly widespread. If this product is dangerous, it is crucial to find this out earlier rather than later. When the possible environmental damage is as significant as it is in this case, there is an especially urgent need to disseminate the relevant data as quickly as possible.

This paper should certainly be published. While the experiment described is preliminary, the results are highly significant. Too little testing has been done to evaluate the effects of Bt corn on non-target species. Researchers who have investigated non-target effects have sometimes been subject to threats from industry representatives who have an interest in suppressing findings that might damage their companies' bottom line. This small but responsibly designed study should spur further research on non-target effects of Bt and other transgenic crop varieties.

Specific Background Materials for Group 3

GROUP 3: Biotechnology Researchers. Members of this group are scientists working to advance research on agricultural biotechnology, including scientists who contributed to the development of transgenic corn varieties like those used in Losey's experiments. Members of this group have an interest in promoting the results of their research. Because they believe that their work is valuable and environmentally appropriate, they are interested to promote public acceptance and to avoid bad press about existing products like Bt corn. While they are concerned to insure that the technologies they develop are safe, they are convinced that Bt corn is environmentally appropriate and valuable: when appropriately used, crops like Bt corn should reduce pesticide use. Some members of this group regard the paper by Losey and his team as an attack on their work. Public acceptance of other valuable biotechnology may depend in part on the success of Bt corn. Members of this group believe that agricultural biotechnology is valuable and safe, and are interested to refute and discredit any information that indicates otherwise. Note that members of this group are responsible and dedicated scientists. Their interest is to promote the results of their research.

Reasons Against Publication: You should argue that various features of the study make it inappropriate to publish the results at this time. Consider developing some of the arguments below:

- (1) This study impugns a valuable and effective technology without providing any evidence that this technology is risky or unsafe.
- (2) The bad press generated by this study will needlessly damage public perception of biotechnology, will needlessly undermine the profits of companies involved in the development of Bt corn, and risks harming farmers by reducing farm revenue. Bt corn is necessary to maintain U.S. agricultural production, and should not be needlessly disparaged.
- (3) Articles that question the value of transgenic technologies may set back research and undermine funding for this valuable area of innovation.
- (4) This article provides ammunition for irresponsible anti-GMO activists who will mis-use the results of this study to raise broad and irresponsible fears and concerns.
- (5) The title of this paper will be predictably misinterpreted by the public, since the non-scientific public does not distinguish between 'harm' and 'risk.'

Note: As you read the fictional reviewers' report on the next page, consider the arguments offered and their relevance to the decision whether or not this article is ready for publication. Note that, in this case, considerations about the experimental design are relevant to the publication decision: it is impossible to answer the question whether the paper is ready for publication without considering whether the experimental design was appropriate. You will need to argue for the position described in this report, but you should also think critically about the reasons offered. Be ready to respond to objections from members of other groups. In particular, be prepared to respond to the charge that the criticism offered here is excessive, and driven by non-scientific economic concerns.

Reading for Group 3: Letter to Journal Editor

To: Nature Editorial Review Board

We are pleased to have this opportunity to respond to this poorly designed study, purporting to show that Bt corn pollen is dangerous to monarch butterfly larvae. Competent readers will see that this paper is not presently ready for publication in any reputable scientific journal.

First, (and as other reviewers have noted) the authors do not provide evidence relevant for the evaluation of the risk supposedly posed to monarch larvae by Bt corn pollen. They have not yet done the basic groundwork to identify the likely level of exposure, the proportion of monarch butterflies that reproduce near corn fields, or the likelihood that larvae faced with pollen-dusted leaves will simply move to another plant.

Second, the study is not reproducible because the laboratory conditions are not described in sufficient detail. Follow-up researchers are left in the dark about the actual exposure levels used in this study, and no information is given about the corn variety that was the source of the “untransformed pollen” in the control group.

Third, the result reported—that at some level, Bt corn pollen may have detrimental effects on non-target lepidopteran larvae—is unsurprising. We already knew that at some level the Bt proteins should be toxic to lepidopterans. But there was no reason to believe—and this study provides no new reason to believe—that this creates a risk to monarch larvae. Without dose information, and information about actual field conditions, this study simply tells us what we already knew to be true.

Finally, the title of this paper is dangerously misleading: “Transgenic Pollen Harms Monarch Larvae.” The title clearly implies, and will be taken to mean that the Bt corn farmers plant harms monarch larvae. Most people reading this title would conclude that transgenic pollen is a significant risk to monarchs, but the study doesn’t show that there are any significant risks under actual field conditions. But the experiment has not been designed to show that: in order to show that Bt corn pollen actually harms monarch larvae, it would be necessary to gauge the amount of pollen on milkweed leaves around actual cornfields, and then test whether pollen at that level has an effect on monarch larvae. This would have been easy to do, but the researchers did not do it: they include no measurement of the amount of pollen used except to say that it was “set to visually match densities on milkweed leaves collected from corn fields.” This is excessively and unnecessarily vague. And why select monarch butterflies as the test species? They are a charismatic and widely loved species. Children grow monarch larvae in classrooms all around the country, so they are the perfect species to use if one wishes to generate unjustified concerns. “Danger to monarchs” is an ideal slogan for fear mongers. The incendiary title of the paper is especially inappropriate since the paper provides no evidence that farmers put monarch larvae at risk by planting Bt corn.

Then there is the use of the word “harm,” which has a very specific meaning in scientific contexts, but quite different connotations in ordinary public discourse. To say that a substance can cause “harm,” in scientific circles, is not to say that it is dangerous. At some dose, almost any substance will cause harm: Water can be harmful if the dose is high enough, but that doesn’t mean that water is dangerous or risky or toxic. Some harmful substances pose very little risk, or no risk at all. To the public, however, ‘harm’ and ‘risk’ have very similar meanings. When the public reads that “Transgenic pollen harms monarch larvae,” they interpret this to mean that monarch larvae are at risk. But this study doesn’t show that there is any risk.

Why would these researchers go to the trouble to conduct a study that tells us, in uninformative and unscientific terms, what we already knew? The evident motive is publicity: There is, an

active movement working to spread fear and misinformation about transgenic crops, playing on people's fear that these crops may have unintended effects on the environment. Because of this, many activist groups are eager to find any morsel of cherry-picked data that implies that these crops are dangerous. The present paper will not provide these groups with actual scientific evidence that Bt corn is environmentally inappropriate, but it will provide them with plenty of sound-bite ammunition that can be misleadingly used to imply what the research does not show. Nature should not publish a paper that has been framed to facilitate misuse.

Bt corn has increased yields and has effectively reduced the amount of pesticide farmers need to use. It is an environmentally appropriate way to address a common pest—the European corn borer—which would otherwise be addressed using more hazardous chemicals. This article, if published, would generate needless concerns about an excellent and valuable agricultural product. By all means, publish research that fairly investigates the risk posed by Bt corn to nontarget species. But don't publish this incomplete and seriously misleading study.

Specific Background Materials for Group 4

GROUP 4: Authors Research Team, Cornell University. Members of this team are scientists responsible for the research in Losey (1999), and are eager to promote the publication of their work. As a member of the research team responsible for this paper, you have many of the same interests as members of the groups above: like them, you have a general interest to maintain the integrity of the published scientific record and the integrity of the process by which articles are reviewed for publication. As researchers, you are interested to insure the publication of scientific findings and the advancement of scientific knowledge more generally. You have the additional motive of self-interest: members of this team have a personal as well as an impartial interest in the publication of this paper, since it is their own work. As a member of this group, you should be prepared to respond to the arguments of skeptical reviewers and industry representatives, and to defend the integrity and value of the research reported in the paper.

Reasons for Publication: You should argue that this study is methodologically sound, good science, on an under-researched and important topic. It should be published immediately. Consider developing some of the arguments below:

- (1) This is a solid, if limited study: the science is good, and the stated results are fully supported by the methodology used.
- (2) Many of the scientific critiques of this paper focus on the fact that this study is “incomplete” in the sense that it raises more questions than it answers—for example, questions about field exposure and risk. But all scientific studies are incomplete in this sense.
- (3) Critics who urge that the reported methodology is unreproducible are just wrong: anyone can go through the procedure just as we describe it and can check our results for themselves.
- (4) This paper is valuable in part because it will motivate further research on risks posed by Bt corn to nontarget species.
- (5) The product in question (Bt corn) was introduced on the market with too few studies of unintended consequences and effects on non-target organisms. In this context, it is especially important to spur additional research.
- (6) Industry groups put pressure on the research team not to publish. In this context, if Nature were to fail to publish the results, this would be giving in to inappropriate industry pressures.

Note: As you read the fictional letter (not written by Professor Losey or his team) on the next page, consider the arguments offered and their relevance to the decision whether or not this article is ready for publication. Note that, in this case, considerations about the experimental design are relevant to the publication decision: it is impossible to answer the question whether the paper is ready for publication without considering whether the experimental design was appropriate. You will need to argue for the position described in this report, but you should also think critically about the reasons offered. Be ready to respond to objections from members of other groups. In particular, be prepared to respond to the charge that the criticism offered here is excessive, and driven by non-scientific economic concerns.

Reading for Group 4: Letter to Journal Editor

To: Nature Editorial Board

We are pleased to have this opportunity to respond to comments and reviewer reports this journal has received regarding our paper discussing the effect of transgenic pollen on monarch butterfly larvae. We begin by addressing the most prevalent, and in the view of our critics, the most damning criticism of our work: this study is incomplete, and does not provide adequate information to evaluate the risk monarch butterfly larvae face in field conditions. Note that this “criticism” simply restates what we say ourselves in the last paragraph of the paper. No study answers all the questions it raises, and it is no weakness in our work that it does not do this.

Other critical remarks are similar, and in fact related: It is noted that we did not specify the variety of non-transgenic corn from which we took the pollen used in the control group, and that we did not specifically measure the density of pollen on the milkweed leaves beyond except to make a visual match between pollen densities seen in the field, and pollen densities reproduced in the lab. It is claimed that these omissions make our experimental design un-reproducible, but this is just not true. Anyone wishing to reproduce our work can similarly make a visual match between leaves in the field and leaves in the lab, and can compare the relative toxicity of transgenic pollen to untransformed pollen from any widely used corn variety. We chose an untransformed variety that happened to be on hand. But further studies could make more specific comparison between different varieties. We hope this work will be done. In fact, we hope that publication of this paper will spur others to undertake this work.

One reader claims that our results are unsurprising, since it would be predicted that Bt pollen would be toxic to lepidopterans. But this is wrong: some lepidopteran species (corn earworms, for example) are not responsive to Bt. And there is every reason to believe that different species will be differently responsive. Our study identifies a hazard to monarch larvae, and identifies a novel and until-now uninvestigated means by which monarch larvae may ingest Bt toxin from transgenic corn.

Before our work in this study, no one had investigated Bt protein exposure in non-target species that occurs when pollen falls on the favored food source. If the level of pollen-dusting is sufficiently dense, monarch larvae won't recognize milkweed as a food source. Our study showed that the larvae will still eat milkweed leaves when the dusting level is dense enough to be toxic. This is an important and novel finding, and our study and methodology were well suited to confirm it. We hope that publication will result in further testing that will more clearly characterize the risk to non-target species.

Finally, critics note that the title of our paper uses the term “harm,” and projects that the nonscientific public will misunderstand this word. It is difficult to predict what the public will understand or misunderstand, but in a scientific journal like *Nature*, it should be sufficient that the title states exactly what our study shows.

When this crop is already growing on hundreds of thousands of acres, it would ordinarily be remarkable that more work like ours has not been done to characterize the existence of a hazard to non-target species, and to quantify the relevant risks. But in this case it is not remarkable: even while under review, our paper has generated a huge and sometimes nasty discussion.

There has been significant inappropriate pressure on us not to publish this paper. Members of our team have even been threatened by companies that say they won't fund our future research if we publish it. Such controversy generated would normally be far beyond the significance of a rather small paper, but in this case there is a well-funded industry responsible for the development of new transgenic crops. Representatives of that industry are eager to prevent and apparently to

suppress scientific research that might raise questions about their product. We are not opposed to the use of Bt corn, nor are we opponents of GM crops in general. But we do think these crops should be studied carefully, hazards identified and risks analyzed. In the case of Bt corn, much more work should be done to characterize the risks to non-target species. We hope that our work will motivate others to undertake this important task.